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Weather-condition-regulated, heated 3-D sonic anemometers (CSAT3AH and CSAT3BH): Working rationale, operation algorithm, and performance assessment

Hayden Mahan[1], Tian Gao[2,3], Xiufen Li[4], Troy Forbush[1], Kris Payne[1], Quan Yang[5], Yanlei Li[1], Haitao Zhou[6], Shangming Wu[4], Ning Zheng[5], and Xinhua Zhou[1]

[1]Campbell Scientific, United States of America (hmahan@campbellsci.com)

[2]Qingyuan Forest CERN, CAS, Shenyang, China

[3]CAS-CSI Joint Laboratory of Research and Development for Monitoring Forest Fluxes of Trace Gases and Isotope Elements, Insitute of Applied Ecology, CAS, Shenyan, China

[4]Department of Agricultural Meteorology, Shenyang Agricultural University, Shenyang, China

[5]LICA United Technology Ltd., Beijing, China

[6]Beijing Techno Solutions Ltd., Beijing, China

Three-dimensional (3D) sonic anemometers are commonly used to measure 3-D wind in eddy-covariance systems for the fluxes of momentum, sonic temperature, and when integrated with fast-response gas analyzers, the fluxes of CO_2/H_2O. A 3-D sonic anemometer has three pairs of sonic transducers spatially positioned with optimized geometry for 3-D wind measurements. The three pairs form three individual sonic paths, each of which is between paired transducers mutually emitting and receiving ultrasonic signals. The transmitting time of the signals in reference to the sonic path length is used to calculate air flow speed and sonic temperature at high frequencies, which can be used for flux computations. However, under unfavorable weather conditions the dew, frost, snow, and/or ice often deposit on the transducer signal transmitting surface. The deposition interferes with the transducer emitting and receiving signals, bringing significant uncertainties to the wind and sonic temperature measurements. These uncertainties degrade the quality of flux data and even interrupt the data continuity, especially in climates where this deposition is most frequent. To minimize the uncertainties, and to optimize the data quality and continuity as much as possible, Campbell Scientific developed the weather-condition-regulated, heated 3-D sonic anemometers: CSAT3AH and CSAT3BH. The former is a heated CSAT3A used for Campbell Scientific open-path and closed-path eddy-covariance systems. The latter is a heated CSAT3B, universally configured with any other gas analyzer for eddy-covariance measurements or used as a stand-alone sensor for wind aerodynamic measurements. Both models use the same heating technology equipping a sonic anemometer with an electronic heating controller (CSAT3H) programmatically regulating the power to heat sonic transducers, arms, and the strut. Based on weather conditions (air temperature, relative humidity, wind speed, and atmospheric pressure) and sonic anemometer operation status (diagnosis codes), the controller regulates heat to prevent frozen and liquid deposition from interfering with the sonic signal. The two new models of sonic anemometers were tested and assessed at several locations,

including inside an environment-controlled laboratory chamber, over a forest canopy in a cold region, and at a snow-covered field station at a high plateau. This poster addresses working rationale, operating heating algorithm, and sensor performances.